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A System for Tannery Effluent Treatment

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A SYSTEM FOR TANNERY EFFLUENT TREATMENT

By

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A SYSTEM FOR TANNERY EFFLUENT TREATMENT

When I was asked to appear before this meeting and contribute to some of the technical discussion it seemed to me that many of those in attendance might be interested in a paper presenting some of the details of what seems to be a particularly efficient system for removing the pollution loading from tannery wastewater. We have just completed a demonstration project for the U.S. Environmental Protection Agency on this system, in which the Agency supported the operation for a twelve month period, and during which a significant amount of data was accumulated, representative of summer operating conditions and winter operating conditions. All of the report on that project could not possibly be presented in the time alloted to me today. However, since it is usually not a difficult task to refine and condense technical material I have done just that and will be giving you a version which hopefully will give you an insight into the nature of the system and the results it is capable of achieving. Before going further I would like to acknowledge the aid and assistance of two consultants in this project who were very valuable during design, construction, and start-up stages, Dr. E.R. Ramirez of Swift Environmental Systems, Chicago, and Dr. W.L. Zemaitis, P.E. of Envirobic Systems, Inc., New York. This paper contains some excerpts from material written by them as pertaining to their particular fields, Dr. Ramirez in the primary treatment phase, and Dr. Zemaitis in the secondary.

Introduction

Tanneries in general are pollution intensive industrial complexes, generating comparatively large volumes of high concentration wastewater which historically have been discharged into rivers and waterways without much, if any, attempt toward purification. This paper is intended to present the details of construction, and operating data, including analytical results, for a system which was designed to eliminate most of the objectionable components of a tannery effluent formerly discharged directly into a small river.

Tanneries are not all alike. The basic design of procedures for hide preparation, tanning and finishing vary rather widely according to the kind of raw hides employed and the characteristics desired in the finished leather product. Accordingly the U.S. Environmental protection Agency, in order to better understand the problems associated with pollution abatement, classified the various segments of the industry into seven categories. These are:

Category 1. Cattlehide - Pulp Hair - Chrome Tan
2. Cattlehide - Save Hair - Chrome Tan
3. Cattlehide - Non Chrome Tan
4. Thru-the Blue
5. Retan only
6. No Beamhouse Tannery
7. Shearlings

In this presentation the category is number seven, Shearlings.

I hasten to say, at this point, that I realize full well that all or most of you are not in the business of running a shearling tannery. Please do not immediately arrive at the conclusion that this does not apply to you. The principles employed are applicable to any tannery effluent as I will point out later on.

A " shearling: tannery is one which tans and finishes sheep pelts with the wool intact, thus producing "skins" which, except for alterations of character and appearance to accomplish permanent preservation, and enhance aesthetic qualities, are essentially the same entity as when removed from the parent animal. The pelts are received either green salted or dry salted in railroad cars or auto trucks from large scale meat producing points in the midwest, far west, or Atlantic seaboard. The pelts contain large amounts of animal grease and interfibrillary water soluble proteinaceous compounds in the form of glycomucins and the like, within the skin substance, as well as large quantities of lanolin, wool grease, and animal soil attached to or entrapped in the wool. These components are removed early in the processing procedure during washing operations, the grease and lanolin being coaxed into dispersal through the use of strong detergents and emulsifiers.

Plate I - Shearling as received and after washing

The wastewater treatment system selected for the Winchester Tannery and upon which this paper is based, was chosen, of course, from a number of options. The electrochemical primary system, sometimes called Lectriclear, was favored for several reasons:

1. The presence of large quantities of emulsified lanolin, wool grease, and animal fat, as well as spent fatliquor solutions, all well dispersed, dictated a clarification system which would involve flotation rather than gravity separation.
2. It was clearly demonstrated on a laboratory scale that the floated skimmings would have a much higher solids content, perhaps on the order of 10X, than a gravity system could deliver, and thus sludge storage, handling and dewatering would be expedited.
3. The continued flotation effect provided by the electrodes in the flotation basin seemed to be in the direction of maximizing primary clarification.
4. The electrolytic generation of chlorine coincident with the other products of elecrolysis appeared to be beneficial side effect that could be expected to provide some disinfection.
5. At the time of selection it was thought that reduction of ammonia was occurring within the Lectriclear system, and this was a possible plus. Later this was found to be untrue.

The secondary system was likewise selected from a number of possible choices. The Carousel concept was brought to our attention by E.P.A. and leather industry representatives who visited Holland in 1974. They reported rather enthusiastically as to the simplicity of design, low cost, and minimum land requirement, as well as adaptability to norhtern winter climate operation, ease of control of dissolved oxygen, and low operating cost. In addition, and most important, it was claimed to have the capability of not only nitrifying, but denitrifying as well. Because all of these factors seemed to indicate superiority over other known systems consultant help was secured and the decision made to install a Carousel unit.

The third essential choice involved the sludge dewatering device. Since land area on the tannery property is limited it was obvious that the solid waste from the treatment plant would have to be deposited at the regional solid waste management facility. Samples were submitted. The material was accepted with the

stipulation that the dry solids content would have to consistently reach 35-40%, preferably 40. Since we were aware of only one device which could reliably be expected to provide this performance it was not difficult to recognize the need for a filter press.

The choices made in assembling this treatment plant have proved to be wise. Consistent high degree removals of pollutants have been achieved, in most cases well in excess of discharge permit requirements. Ensuing sections will go into this in detail.

Characterization of Process Discharge

Shearling processing is a complex procedure using a much greater water to hide ratio than most tanneries. Since the wool is retained, and it is desired to keep the wool fibres as ttached to the pelts free from interweaving and tangling, the practice has developed to "swim" the skins in chemical solutions rather than limit the chemical floats to the smallest possible amount, as has become the practice in other categories of tanning operations. The liquor to skin ratio, by weight, for each fill and drain, is on the order of 2.5 to 1. With side leather the ratio is apt to be 1 to 1, and in some individual instances may be as little as 0.25 to 1. The Winchester tannery uses approximately 90 gallons of water per pelt, 7500 gals. per 1000 lbs of green salted weight as received, or, on a weight basis, a ratio of 60 to 1. This seems very high but is necessitated primarily by the extremely soiled condition of the pelts au naturel. The tannery processes some 3000 skins per day and discharges just under 300,000 gallons of wastewater per day.

The process used at Winchester has been envolved over many years of trial and error and gradual optimization by experience. There is no close knit shearling trade group in the U.S. exchanging ideas for mutual benefit, nor is there any standard procedure for converting raw pelts into finished product. Many tannages are used in our tannery, ranging from glutaraldehyde to modified mineral and vegetable tannages, depending upon the end use and characteristics desired in the finished shearling. In this section we intend to generally describe the wet processing steps, those contributing to liquid waste volumes, so that a reader will have some concept of the sources and reasons for the liquid waste components.

The shearling process consists of the following steps:

A. Soaking and washing
B. Pickling
C. Tanning
D. Retanning, dyeing, and fatliquoring
E. Drying
F. Dry Finishing

A. Soaking and Washing

Chemicals Used:

Soda Ash
Detergents (Biodegradable)
Bactericide

Skins are immersed in water in batches of about 100 skins, in a horizontal semi cylindrical wooden tub upon which a paddle wheel is mounted. The above chemicals are added and the paddle wheel is rotated to provide swirling action which enhances liquid contact with both the skin and the wool. There are a number of fills and draws during washing and rinsing cycles. This is an overnight operation.

B. Pickling

Chemicals Used:

Sodium Chloride
Sulfuric Acid

Skins are immersed again in paddle vats, and gently agitated, this time in 5% salt brine containing sulfuric acid sufficient to adjust and maintain the pH to about 1.8. This also is an overnight operation. Equiblibrium at the pH specified is achieved.

C. Tanning

Chemicals Used:

Sodium Chloride
Basic Chromium Sulfate
Sodium Formate

Skins are again immersed and gently agitated in paddle vats containing now the chromium tanning solution. This requires two day exposure. In some cases, depending upon the product desired, the chromium solutions' are retained and reused. In others, certain dyes are added which prevent reuse.

D. Retanning, Dyeing, and Fatliquoring

Chemicals Used:

Sodium Chloride
Basic Chromium Sulfate
Sodium Formate
Emulsified Animal, Vegetable, Fish, and
Mineral Oils
Various Dyestuffs

Similar equipment to that described in the foregoing steps is employed. The only significant difference in this dyeing and fatliquoring sequence is that much higher temperatures can be tolerated by the now chrome tanned skins and such elevations can be used to advantage in the exhaustion of the dye baths and fixation of the dyestuffs. The times consumed are relatively short, on the order of two to three hours.

All of the above operations are carried on at the ground floor level of the tannery, and the liquid contents of the paddle vats discharge by gravity to in-floor drains and sewers. This means that is is possible for a number of vats to be discharging dissimilar solutions to the wastewater collection system at the same time. Generally the soak waters are the first to be sewered in the workday, beginning about 3 a.m., and lasting until 3 p.m., the pickle liquors are dropped from about 11 p.m. to 11 a.m., tan liquors from 7 a.m. to 2 p.m., and color-fatliquor solutions from 7 a.m. to 3 p.m. This accounts for the equalizing tank at the front end of the wastewater treatment works, where not only the dissimilar solutions are blended, but surges in hydraulic flows are absorbed.

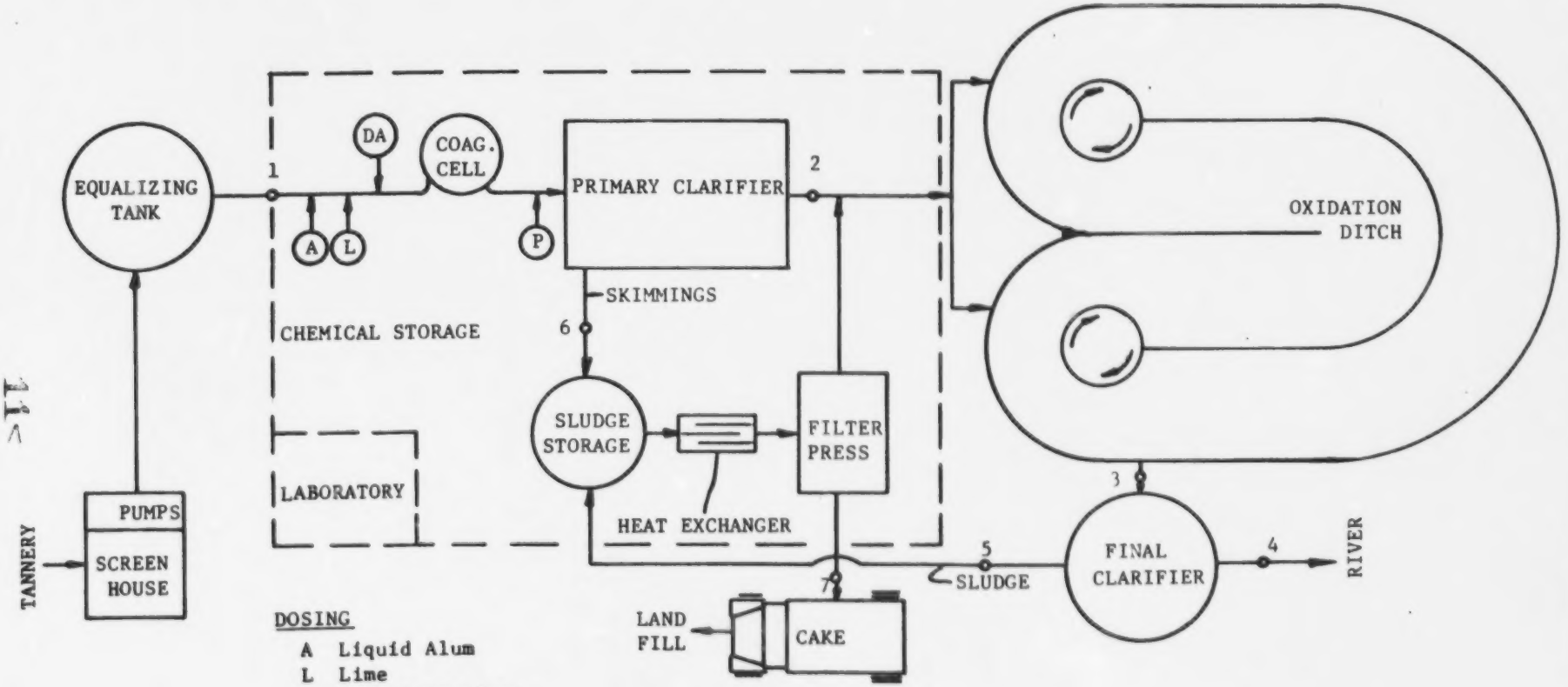
The blended waste stream is thus a complex mixture of organic and inorganic chemicals, tanning materials, both mineral and vegetable, mineral, animal and vegetable oils, both raw and solublized, and a spectrum of dyes. It is a murky brew at best, sometimes red, sometimes blue, usually dirty gray, but always bad, and a challenge to any sanitary engineer. A typical analysis of a compsite sample from the equalizing holding tank is as follows:

	mg/l
Suspended Solids	1295
B.O.D.$_5$	840
NH_4-N	32
T.K.N.	78
F.O.G.	443
Cr.	109

While this analysis may not appear to represent contamination loads encountered at chrome side tanneries, it is not as different as one might expect.

Later in this report the subject of application of the treatment process described herein to chrome side production and veg tan effluent will be discussed.

SCHEMATIC OF PRIMARY & SECONDARY TREATMENT SYSTEMS FOR WINCHESTER, NH



DOSING

A Liquid Alum
L Lime
P Polyelectrolyte
DA Dispersed Air device

SAMPLING POINTS

1 - Equalized Influent - to Primary Clarifier
2 - After Primary Clarifier - to Oxidation Ditch
3 - After Oxidation Ditch - to Final Clarifier
4 - Final Effluent - to River
5 - Final Clarifier Sludge
6 - Primary Clarifier Sludge
7 - Compacted Sludge

Plate II Holding Tank

Plate III Constant Head Box

Primary Treatment and Clarification

Evaluation of processes for primary wastewater treatment began at Winchester in 1971. During that year, following laboratory bench scale work, an electrolytic microbubble suspended solids flotation pilot plant was designed and constructed, capable of treating 15 gallons per minute. The preliminary runs with this equipment were encouraging but not successful because of incomplete flotation of solids.

Modifications were made, and during the summer of 1972 preliminary test runs were repeated. These pilot tests clearly showed that the electroflotation basin, by itself, was inadequate to give reproducible and consistently acceptable treated wastewater. Finally, in 1973, an electrocoagulation cell was developed, designed, and installed just ahead of and in series with the electroflotation basin. This was the key to reproducible, consistent, and acceptable results.

During the summer of 1974 'round-the-clock runs were made operating one pilot unit at 12 gallons per minute. these tests lasted for several weeks and the results conclusively showed that the two-step electrocoagulation technology could provide the results desired.

Theory of the 2-Step Electrocoagulation Process

The theory of the 2-step electrocoagulation cell has already been adequately described in a number of papers. The basic underlining principle of this primary treatment is the addition of microbubbles to the wastewater after metal coagulants have been added and prior to the addition of a polyelectrolyte. This principle is especially important in wastewaters that have suspended material of high specific gravity (3 and higher). In the electrocoagulation cell, the surface charge on the pollutant particulates are neutralized by the metal coagulant. This condition brings about a growth in aggregate size of the pollutants. Under these circumstances the high density of the pollutants invariably leads to a rapid settleing action. The noteable contribution of this new two-step technology is the addition of a buoyancy factor (microbubbles) to the pollutant particulates.

Pairing off particulates and microbubbles is enhanced either by vortex action or other turbulences because it increases the collision probability between pollutant aggregates and microbubbles. The collision and subsequent union of microbubble and pollutant particulate creates a two-phase agglomerate consisting of microbubbles and suspended materials (see Figure 1). Once this condition has been achieved, the addition of the polyelectrolyte flocculates the solid-gas aggregates and forms a gross-floc which is buoyant.

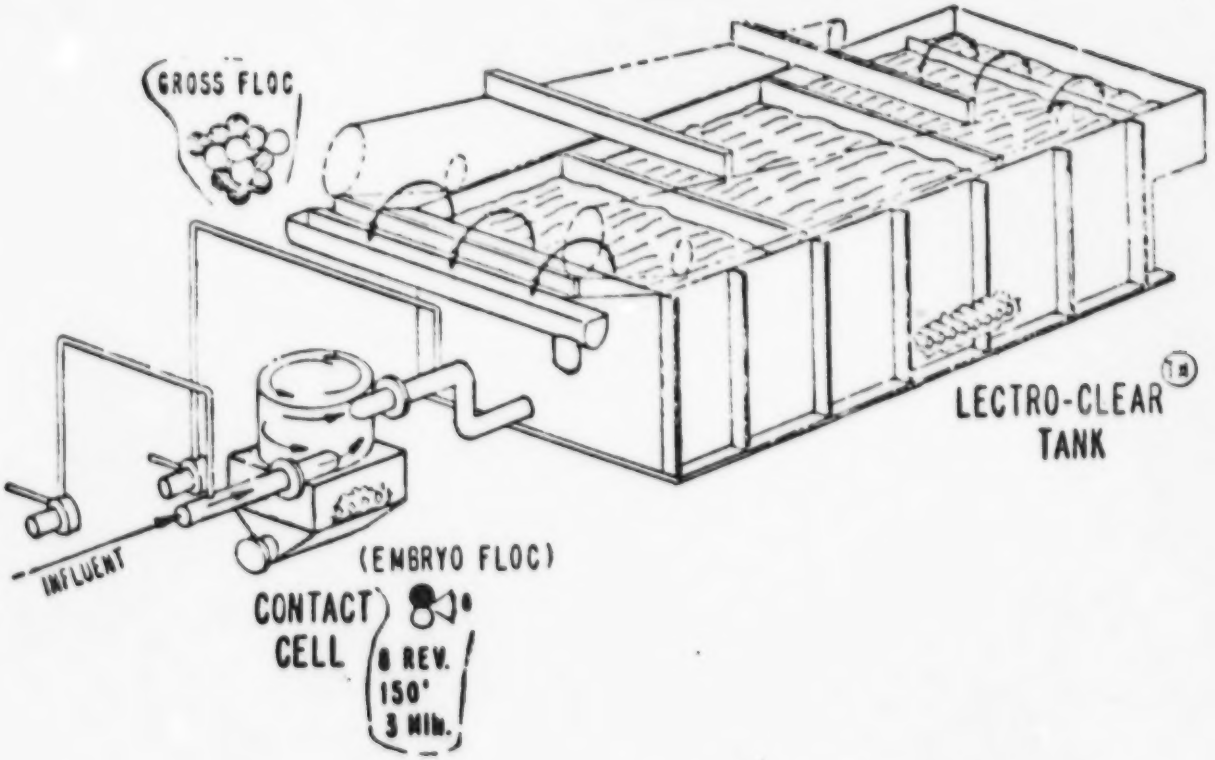
In the initial work at A. C. Lawrence Leather Company, only electrolytic microbubbles were employed in the coagulation cell. Since that time extensive tests have shown that dispersed air as well as dissolved air can effectively be used in the two-step process. Single step jar tests carried out with direct dissolved air flotation were not successful. In summary, this two-step concept provides a new and useful technology for treatment of industrial wastewater.

Dispersed Air Coagulation Cell Versus Electrocoagulation Cell:

An electrocoagulation cell employing electrolytic microbubble generation was initially the only source of flotation and was evaluated at the Winchester plant. The cell contained 126 TA-2 electrodes with a horizontal surface-to-surface spacing of ½ inch. These electrodes were placed beneath the wastewater flow pattern and were situated below the coagulation cell proper. The electolytic microbubbles generated at the electrodes rose to the center of the vortex coagulation section by natural buoyancy. The wastewater enters and leaves the coagulation cell tangentially. The design called for the coagulation cell to use between 6 and 7 volts DC and to provide a DC current of approximately 3000 amperes. Under these conditions the volume of electrolytic gases generated was 30 liters/minute (STP) (2.0 volume percent of the wastewater treated). Microbubbles which coalesced in the coagulation cell were vented through a 3-inch pipe in the center of the vortex coagulation unit. A schematic of the two-step pretreatment operation at Winchester is shown in Figure 2.

FIG. 2

SCHEMATIC – WINCHESTER INSTALLATION



Quite early on problems developed in the electrolytic microbubble generation section. The wooden electrode supports rather quickly deteriorated and some electrodes shorted out. There were also problems with wool and debris accumulation on and around the electrodes which interfered with good bubble formation. In looking for relief our consultants suggested using and in-line mixer which, when properly supplied with air, could cause minute bubbles to form directly in the waste stream. This equipment consists of an in-line mixer produced by Lightning Mixer. A photograph of this unit in place is shown in Figure 3. The in-line mixer is in a 10-inch diameter pipe which is placed just prior to the vortex coagulation cell. Compressed air (10psi and higher) is fed to the bottom of the in-line mixer.

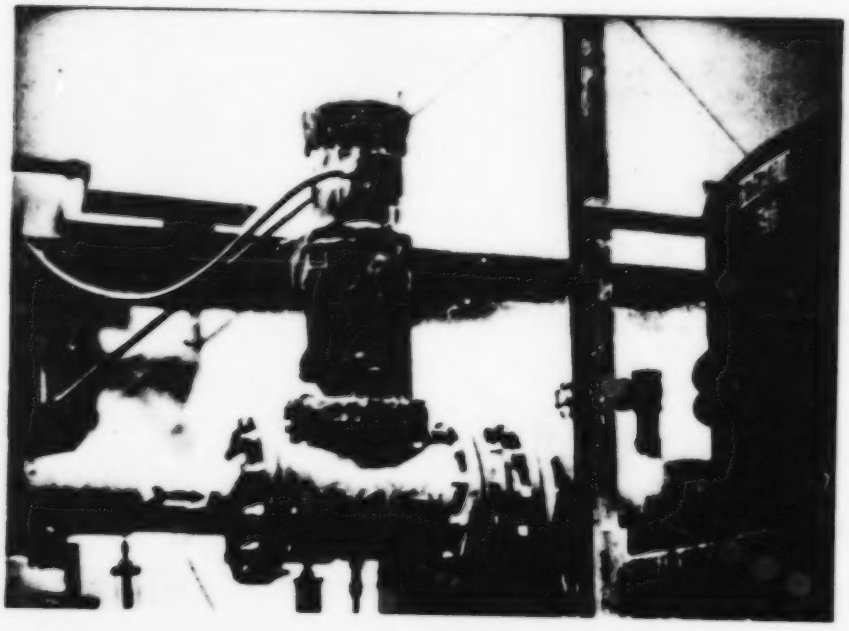


Plate IV. Dispersed Air Generator

Air volume is regulated into the in-line mixer by a rotometer valve which was adjusted for a flow of about 2 cubic feet (56.6 lt) per minute (STP). A critical part of the dispersed air device is the use of a bubble fractionator. The microbubbles generated by the dispersed air device are definitely coarser

than those generated electrolytically. A small percentage of bubbles in the dispersed air device are very large and approaching 2000 microns in diameter. These microbubbles are deleterious to the overall process and must be removed in the fractionator. For the installation used at Winchester, the fractionator was placed approximately 10 feet downstream from the vortex coagulation cell (see Figure 4). The overall size of the microbubble fractionator is 3 feet by 3 feet by 4 feet high. Bubbles larger than a certain size (approximately 400 microns in diameter) exit from the wastewater in the fractionator. The fine bubbles (due to their slow rise rate) are held in the hydraulic flow pattern.

Plate V. Bubble Fractionator

Failure to use a bubble fractionator will invariably lead to poor results in the electroflotation basin since the wastewater will carry large bubbles into the flotation basin where turbulence created by the coarse bubbles break up the floc as it is being skimmed off the flotation basin.

One of the most important components in this treatment system follows next in the sequence, the Lectriclear flotation basin. The design was furnished by Swift Environmental Systems, Chicago, the holder of patents in connection with the application of this device. It contains microbubble producing electrodes which perform two main functions, the first being to provide assistance to stray floc agglomerates which may not have acquired enough bouyancy in the coagulation cell, and help them to the surface, and the second being that as microbubbles rise and encounter the underside of the floating sludge blanket they add bouyancy and raise the top of the blanket above the water surface. As a consequence of this action substantial dewatering occurs through downward flow of

water and the solids content of the skimmed sludge increases to as high as 10%. In actual practice the operators say things are right when the skimmings look like wet crumbly gingerbread.

This electroflotation basin is described as follows:

Rectangular - 33 feet long
11 feet wide
5 foot water level (see Figure 8) and Figure 9)

Skimmer Arms - Mounted on top, full width.
Supported and moved by link chain.
2 x 6 wood timbers, 10 ft. apart.
Travelling @ 2.5 ft. per minute

Four Baffles - Vertical. (to prevent channeling
Equally spaced in the basin. Perpendicular to direction of flow.
3 inch round holes, 4" centers
One inch marine plywood

Duriron Electrodes - Seventy eight Type TA-2
Operated in pairs - surface to surface spacing one-half inch.
Mounted in polypropylene cradles, 10 inches above bottom of basin.
One half are located in the first quartile of the basin.
Current requirements 1500 Amp, 7 volts DC

Screw Conveyor
Horizontally mounted on the sludge discharge end of the flotation basin so as to receive sludge from the skimmer arms and direct the same into an open top vertical receiving tank.

The skimmings, now containing almost all of the influent suspended solids, are directed by the screw conveyor on the Lectri Clear flotation basin to a transfer pump and thence into storage tanks to await charging into the filter press during the normal working day. They are withdrawn from the storage tanks by means of an air actuated diaphrgm pump called a Sand Piper which is particularly efficient for this purpose. At the end of the charging cycle the pump is working at 100 p.s.i. and thus creates a very solid cake in the press. Filtration and compaction are enhanced by raising the temperature to 150^{0} F or so, hence the inclusion of a heat exchanger between the Sand-Piper and the filter press.

The Filter Press has the following general description:

Manufactured by W.R. Sperry Co., East Aurora, Illinois, U.S.A.
75 rectangular 4' x 4' press plates
Center feed, corner discharge,
diamond pyramid face pattern.
Polyester non-woven press cloths.

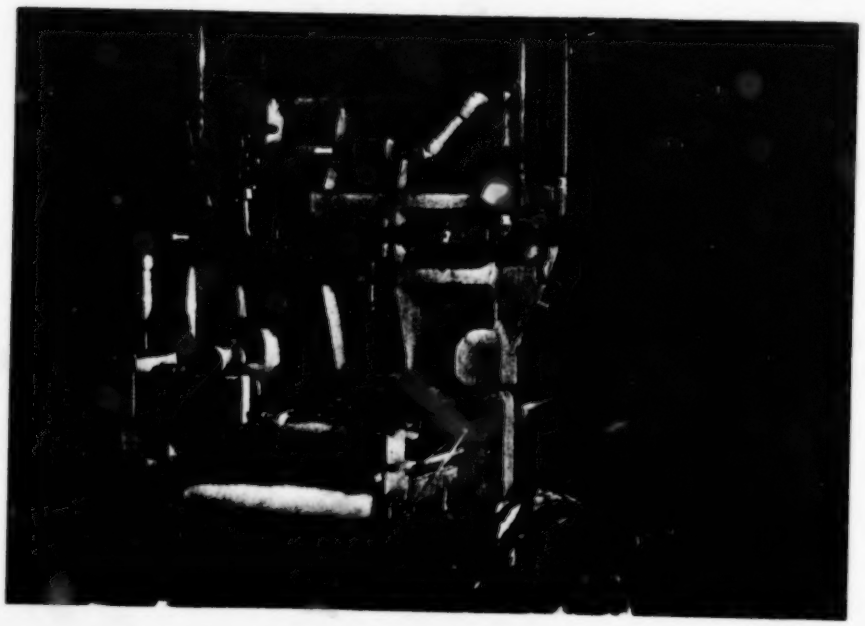


Plate VI - Filter Press

Operation of the Primary Section:

The plant obtains about 90% of its water for processing from the Ashuelot River. Drinking water and certain limited plant processing steps use city water. Dumping of the water used for processing the pelts occurs between the hours of 3 a.m. and 7 p.m. A peak in hydraulic wastewater flow occurs at about 11:00 a.m. As the wastewater leaves the plant it is passed through a stainless steel cylindrical Stahling screen where some of the wool fiber is removed. From this point the water passes into a 3000-gallon pit and it is then pumped directly into the 160,000-gallon holding tank. Wastewater in the holding tank is lifted by an immersion pump and passes through a head box which provides the hydraulic head to feed the primary Lectroclear system. pH of the wastewater in the holding tank varies between 5.1 and 7.2. The head box is approximately 15 feet above the LectroClear operation. This hydraulic head provides a flow of about 300 gallons per minute and the wastewater flows by gravity from the headbox to and through the entire primary phase.

On leaving the head box (in a 10-inch pipe), 1000 mg/l of alum is added to the wastewater. At a distance of approximately 20 feet from the alum addition and just prior to the dispersed air device, 800 ppm of hydrated lime is added from a 10 weight percent lime slurry. Both chemical additions are added by metering pump manually set to a predetermined feed. The wastewater then passes through the dispersed air device, and the vortex coagulation cell for a dwell time of 2.2 minutes after which 12 mg/l of polyelectrolyte is added (X-400 Swift anionic polyacrylic acrylamide). At this point the pH is consistently between 7.5 and 8.5. pH is monitored frequently and deviations from the just-above-neutral zone are correctly by adjustment to the lime feeding mechanism.

It must be said here that it was and is the intention to control pH by automatic adjustment to lime feeding. Equipment was provided for this at the outset but thus far manual adjustment has not only been found to be adequate, but more reliable.

The system is designed ans an "on-off" operation. This "on-off" control is carried out by a float valve in the holding tank. When the water in the holding tank is above a predetermined level, the float valve keeps all pumps and power on, and conversely when off, all off.

Secondary Biological Treatment - The Carousel

Now we will proceed to consider the Secondary Phase of this wastewater treatment process, biological reduction using an oxidation ditch of proprietary design known as a "Carrousel".

The Carrousel concept was first applied to sewage treatment in 1968 at Oosterwolde, Netherlands. Today there are over 100 installations in operation. Sizes range up to 300 MGD flow with 500-600 mg/l BOD (BASF - Germany). Dairy, food, tannery, brewery, chemical, pharmaceutical, and paper industry wastes have all been successfully treated. Although the Carrousel has been extensively applied throughout the world the first plant in the United States went on line in December 1976, at A. C. Lawrence Leather Company, Inc., Winchester, New Hampshire, the subject of this report.

Background of the Carrousel:

The Carrousel is a technical modification of the original oxidation ditch developed during the 1950's by Dr. Ir. A. Pasveer of the Netherlands TNO (Research Institute for Public Health Engineering), Delft, Holland. Several thousand of these oxidation ditches are in operation world-wide. Aeration in the original ditches is supplied by horizontally-mounted cage rotors whose oxygenation rates and amounts are dependent upon the rotor design, immersion depth, and the revolutions per minute.

The extended aeration process which is used in most oxidation ditches yields a high percentage of BOD, COD and suspended solids reduction and a sludge that has been aerobically digested. This is a result of the endogenous respiration phase undergone by microorganisms.

The Carrousel concept was developed and patented by Dwars, Heederik en Verhey, B.V., Amersfoort, Holland a major European consulting firm. The Carrousel is a hydraulic application of vertically-mounted mechanical aerators which impart oxygen and which, at the same time, provides sufficient horizontal velocity to prevent solids from settling in the aeration channels. Final settling tanks are the only major components needed in addition to the aeration channels for most applications. Settled sludge is returned to the aeration unit with excess sludge being wasted periodically.

The number of aerators and the size is based primarily on the amount of oxygen neede, in turn, the channel cross-section dimensions are based on the aerator impeller size. The channel length is a function

of the volume which is related to the treatment efficiency or the type of activated sludge process seclected. Special shaping is used to optimize the velocity. The platform or bridge must be designed to handle all of the forces and vibrations associated with the aerator.

The common design factors or criteria to produce a BOD reduction of 95 to 99% and a COD reduction of 90 to 95% are as follows:

A. MLSS (mixed liquor suspended solids) = 3500 to 4500 mg/l

B. Loading = 0.05 to 0.10 lbs BOD/lb MLSS/day

C. Oxygen supplied = (2.0 to 2.5) X (BOD)

D. Organic load= 12.5 lb BOD/1000 cu ft = 1.0 lb BOD/80 cu ft

The Carrousel can be operated to achieve good nitrogen removal without additional treatment units and without the use of chemicals for a carbon source. Thorough nitrification is achieved by large numbers of nitrifying organisms maintained in the aeration unit. The high MLSS, the long retention time and the well conditioned sludge are all conducive to good nitrification.

After the organic nitrogen has been oxidized to nitrate, denitrification is accomplished by the denitrifying organisms in the Carrousel by passing the mixed liquor through a zone of controlled low dissolved oxygen (0 to 1.1 mg/l) in which an adequate carbon source is available from the continuarl inflow of raw waste. This may be accomplished by automatic control of the dissolved oxygen concentration using a D.O. probe which can activate the mechanism to change the depth of immersion and thereby the rate of oxygenation. Through this control system a section of the Carrousel is made to operate at or near zero D.O. during which denitrification takes place. Each phase lasts only a few minutes as the velocity in the channel normally exceeds 1 fps. Odor problems do not develop because of the stable sludge condition, as well as the very short time period in the anoxic zone at any one time.

An advantage of incorporating oxygenation control and denitrification in the Carrousel design is that oxygen release during the process is partially used for BOD removal.

In addition to the Carrousel design the final clarifier must be properly designed. The solid flux loading should be limited to 1.0 lb/sq ft/day which amounts to a peak loading of 600 gal/sq ft/day or less.

Plate VII - Carousel Construction

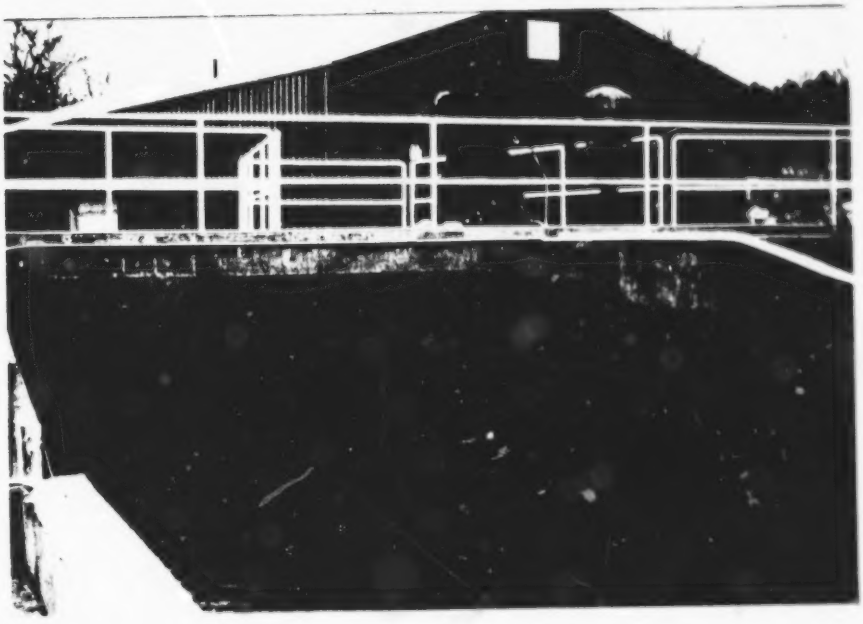


Plate VIII - Carrousel and Aerator

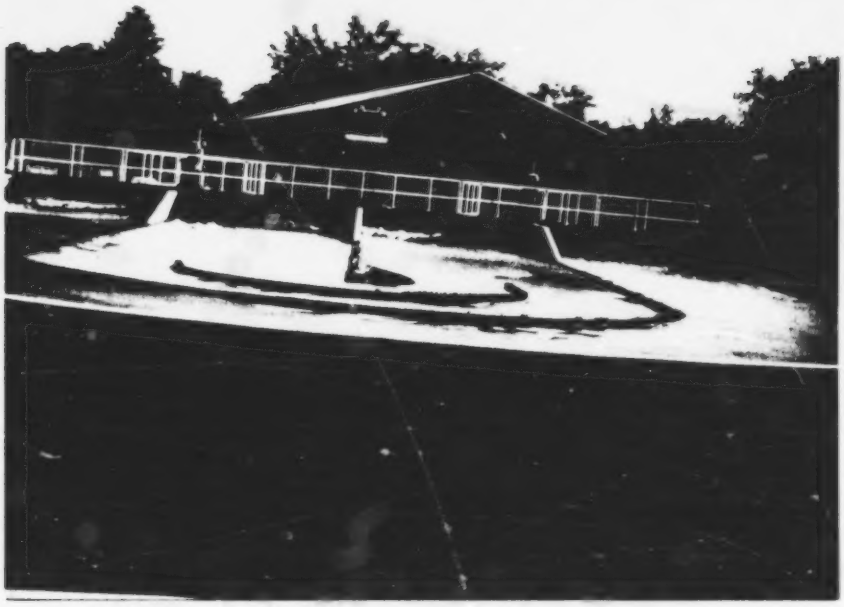


Plate IX Carousel in Operation

Operation of Secondary Section

The secondary, or biological reduction section, is much more simple in day to day operation. Close checks are maintained on dissolved oxygen at selected points in the Carrousel raceway so that an excess of oxygen exists throughout most of the distance. Balance is maintained so that a rather short anoxic area exists just upstream from the discharge weir. Since the system is receiving on the order of 250 g/m when in operation, and the Carrousel contains 380000 gallons, the amount added and discharged during any given minute is very small. The suspended solids are continiously returned to the Carrousel from the final clarifier, or wasted to the sludge holding tanks for a period each day, usually two to four hours. This is required to maintain the suspended solids concentration in the Carrousel at 7000 to 8000 mg./l.

B.O.D. removal is accomplished in the aerobic zones. So is nitrification, or conversion of nitrogenous material to nitrate. The purpose of the anoxic section is to provide for bacterial breakdown of nitrate to nitrogen, which is released to the atmosphere. Odor problems do not develop because of the stable sludge condition, as well as the short time period in the anoxic zone at any one time.

The final clarifier accomplishes removal of suspended solids and allows discharge of a clear, colorless, effluent to the receiving stream.

Results:

The table of analytical figures which follows speaks largely for itself. The degrees of removal of pollutants are given in the two bottom lines, primary and secondary. It is quite apparent after reviewing these results that this system is particularly effective in reducing polluted tannery wastewater to acceptable condition for surface disposition into a river or stream. Particularly please note the high degree of conversion of soluble nitrogenous compounds, not only ammonia, but soluble proteinaceous material into free nitrogen, which escapes as such into the atmosphere.

CHART I-C

DAILY REPORT - PRIMARY AND SECONDARY -- A.C. LAWRENCE LEATHER COMPANY DEMONSTRATION GRANT S804504

Date	Susp Solids S_1	S_2	S_3	S_4	B.O.D.5 Day S_1	S_2	S_4	NH-4-N S_1	S_4	TK-N S_1	S_2	S_4	NO_2 S_4	NO_3 S_4	FOG S_1	S_2	S_4	TOTAL CR S_1	S_2	S_4	ORTHO PO4 S_4
10-3	972	308	10470	80	600	192	3	31	0.7	71	40	3.6	.02	61	1563	134	6.6	100	17.5	1.1	1.3
10-4	954	180	10390	58	690	246	3	34	0.4	70	35	3.1	.01	53	439	104	2.8	85	6.5	0.8	0.65
10-5	732	228	8888	31	683	248	3	32	0.9	73	46	4.8	1.17	48	370	43	2.2	94	11.5	0.9	0.00
10-6	1078	236	10060	32	990	312	5	24	0.4	65	20	2	.01	22	452	25	2.8	100	12	0.6	1.0
10-7	676	118	9730	32	610	216	4	37	0.6	43	28	5	.76	3	265	5	0.8	100	3.5	0.2	0.25
10-11	1022	332	9850	60	870	300	4	34	0.5	79	19	2.8	.11	13	377	21	1.2	85	12	0.4	0.5
10-12	1104	410	9730	64	870	366	7	39	1.4	76	52	4.5	.64	9	454	82	0.8	95	28	0.4	0.12
10-13	1005	412	8669	13	790	347	6	40	2.7	81	56	5.6	.30	10	480	101	18	110	39	0.7	.25 Ortho
10-14	1004	252	10110	40	830	288	4	39	3.5	83	47	7.8	.00	8	415	9	2.8	100	6	0.5	00
10-5	608	316	9700	54	580	312	6	34	3.8	44	27	8.7	.30	5	218	61	1.8	110	27	0.8	00
10-18	1164	142	10620	66	720	252	3	10	0.9	62	32	3.9	.34	23	413	5	4.8	65	1.6	1.0	00
10-19	1080	96	8677	44	881	286	8	36	2.4	80	43	6.7	.00	9	542	24	7	104	4.7	1.5	0.66
Milligrams Per Liter																					
Ave.	945	252	9741	48	759	280	5	32	1.5	69	37	4.8	.30	22	499	51	7.9	96	14.1	0.7	0.5
% Removal P		73.4				63.1					46.3					89.7			85.2		
T				94.9			99.4		95.3			98.0					98.4			99.3	
Discharge Permit Requirements				50			50		1.5								15			0.5	

The Application of the System Described Herein to Chrome- Cattlehide and Vegetable Cattlehide Tanneries

In Section I 'Introduction' to this report it is pointed out that tanneries have been classified into seven categories to better understand the problems associated with each. Three of these categories relate to cattlehide tanneries full scale, meaning that hair removal, tanning, coloring and fatliquoring, and finishing are involved in each.
These are:

Category 1. Cattlehide - Pulped Hair - Chrome Tan
2. Cattlehide - Save Hair - Chrome Tan
3. Cattlehide - Non Chrome Tan

Very few, if any, cattlehide tanneries save hair and chrome tan. More and more the mode has become one of soak,wash and hair burn using strong sodium sulfide liquors, followed by reliming, and consolidated bate-pickle-tan in rapid sequence. Most tanners operating this way reclaim sulfide liquors using one of two or three methods, and all use some system to separate pulped hair solids from the waste stream before discharging to the sewage treatment system.

In a different, but similar manner, all vegetable tanners of real size, employ a hair save process. This system uses much less sulfide and produces a valuable by-product in the form of cattle hair, which has seen a resurgence in value and is now bringing almost as much per pound as it cost when purchased on the hide.

The net result of these on-plant activities has been to reduce high potential waste liquors to levels which are not so far distant as one might expect from those encountered at the subject shearling tannery. It has been stated that a shearling tannery is not a typical tannery since it is neither cattlehide, nor does it have a beamhouse, and therefore wastewater treatment technology transfer is not possible. Since A. C. Lawrence operates tanneries classified in categories 1,3 and 7, and company technicians are familiar with the details of all of the other categories, they have the capability of

recognizing the dissimilarities and parallels. Careful scrutiny divulges that there is not all that much difference.

In order to rather definitely establish the similarity we present the following table of typical analyses of wastewater from our own tanneries, all of which we consider to be more or less representative of complete tanning operations in their respective categories.

Typical Tannery Effluent Analyses

	Side Leather	Sole Leather	Shearling
	Category 1	Category 3	Category 7
Parameter	South Paris, Maine	Hazelwood, N.C.	Winchester, N.H.
B.O.D. 5	1630	686	840
Suspended Solids	2718	1080	1295
Total Solids	5620	5314	14000
Fats,Oils, Greases	580	201	443
pH	10.9	9.9	5.1
Chromium-Cr	187	-	109
NHz-N	14	73	32
TKN-N	126	179	78

All values - mg/l

Examination of this table shows that there is a remarkable similarity in the nature of the wastewater from each. The parameters are not the same, of course, but the significant differences are on the order, for the most part of about 2X. Total volume is considerably greater for the side leather tannery since this is a function of sheer bulk, but it seems remarkable that the pollution level in the wastewater from each is so close, gallon for gallon.

It seems in order then, to take the stance that this described system is in fact suitable for any tannery. We would add one recommendation, however, the primary clarification system is based upon flotation of solids. It seems reasonable to suggest that it would be most efficient to remove the heavy suspended solids usually present in cattlehide tannery wastewater by providing bottom sweeps

and sludge collection cavities in the surge tank. This would not add greatly to the orginal cost, and would remove the heavy solids at the most advantageous point.

With this recommendation we can say without reservation that a wastewater treatment plant, based upon the design principles, primary and secondary, as described herein, carefully engineered and operated, would appear to be capable of accomplishing the same removal and reduction of all parameters, and discharge a treated effluent to a receiving stream, or whatever destination with about the same degree of efficiency.